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(19)

(54) A METHOD OF PRODUCING FERMENTED BEVERAGES

(71) We, VOGELBUSCH GESELLSCHAFT M.B.H. of Mautner Markhof-Gasse 40, Vienna II, Austria, an Austrian Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a method of producing fermented beverages or concentrates which may be reconstituted by dilution to form such beverages, in particular beers.

Various fermenting or brewing processes are known for producing alcohol- and carbon dioxide-containing beverages which are fermented to varying extents. If as basic raw materials there are used grain such as barley or barley malt, or other starch- or sugar-containing materials such as hops or hop derivatives and water treated to a varying extent, for example brewing water, then the alcohol-containing and carbon dioxide-containing fermented beverages obtained by yeast fermentation are generally known as beers.

The resultant alcohol content of the beverage depends according to BALLINGS attenuation low both on the concentration of the original worts and on the degree of fermentation. This applies, though in a different manner, not only to bottom fermenting lager beers, but also to top fermenting beers. With an original wort content of approximately 12° Plato a degree of fermentation of

approximately 80% corresponds to an alcohol content of approximately 4%,
approximately 60% corresponds to an alcohol content of approximately 3%,
approximately 40% corresponds to an alcohol content of approximately 2%,
approximately 20% corresponds to an alcohol content of approximately 1%.

[Price 33p]

The exact ratios also depend on the ratio of fermentable to non-fermentable extract ingredients, that is of sugar to non-sugar, and on the manner of yeast propagation. In this specification the term "sugar" is to be understood to mean all fermentable carbohydrates, calculated as disaccharide, i.e. the amount of fermentable carbohydrates is calculated as if the entire carbon in the carbohydrates were in the form of disaccharides. Usually during beer production substantially anaerobic alcoholic fermentation takes place. From 100 kg of sugar, approximately 58-61 W (1W = 1 litre of ethyl alcohol calculated at 100%) of alcohol and 5-8 kg of dry yeast substance and corresponding quantities of carbon dioxide are formed.

Hitherto the production of low-alcohol beers has been possible only by a corresponding reduction in the degree of fermentation, that is by interruption of the fermentation process. However, all known methods of producing low alcoholic or so-called non-alcoholic beers have so far proved unsatisfactory. The main reason for this is that low fermented beers obtained by premature interruption of fermentation do not come up to consumers' expectations either as regard taste or as regards the other usual properties of the beverage, in particular because of the development of an aroma inappropriate to the beverage.

Methods have also been proposed in which the alcohol is separated from normally fermented beers by physical treatment, such as by distillation. It is also known to produce beer concentrates from normally fermented beers by physical methods, for example evaporation or freezing. These methods also have the disadvantage that they can only be carried out in several working steps and are therefore complicated and expensive.

The present invention relates to a method of producing low-alcohol or non-alcohol fermented beverages and concentrates thereof having an acceptable flavour.

The invention provides a method of producing fermented beverages, or concentrates which may be reconstituted by dilution to form fermented beverages, by fermentation of worts prepared at least partially from grain or malt mashes, comprising carrying out the fermentation under aerobic conditions in the presence of a continuous supply of oxygen or a free oxygen-containing gas into the whole wort to provide from 0.5 to 5.0 kg oxygen per kg of fermentable carbohydrates present in the wort, whereby substantially all fermentable carbohydrates are assimilated by yeast and no or only a little alcohol is formed, separating the yeast off after fermentation, and subjecting the fermented liquid to at least one of the steps of sedimentation, centrifugation, filtration, cold-hopping, adding alcohol, providing a head, carbonation and dilution.

By "providing a head" is meant the addition of new or green beer or wort found in the complete fermentation followed by further fermentation of the entire liquid.

Whether a concentrate or a beverage is produced by the method according to the invention mainly depends on the concentration of the worts added to the fermentation, as well as any subsequent diluting process. If for example a wort with a concentration of 40° Plato is used, then the fermented product is a concentrate which has to be diluted before being used as a beverage.

Thus by suitably conducting the fermentation, yeast yields of 50-60 kg or more of dry yeast substance per 100 kg sugar may be obtained as a by-product, practically no alcohol being formed. Although, according to the invention from 0.5 to 5 kg oxygen per kg of sugar to be fermented is introduced into the fermenting worts, the exact quantity introduced will depend on the effectiveness of the gas-supplying apparatus available.

It is known in yeast production technology that good yeast yields are attainable if a mash is strongly aerated in the course of fermentation, again no alcohol being formed. However, it was by no means to be expected that by such a method, beverages such as beer could be produced particularly as the slops obtained during the usual aerobic yeast production, for example from molasses, can hardly be considered to have an economical application.

Advantageously worts are used in which the weight ratio of fermentable to non-fermentable extract ingredients, that is to say the ratio of sugar to non-sugar, is approximately from 1:0.1 to 1:10, preferably from 1:0.3 to 1:3. In known brewing methods the composition of the sugar-containing worts obtained may be varied within wide limits and can accordingly be adjusted to fall within the ratios given above.

Some important variable parameters in brewing are the water quality, the type of malt and raw product, that is unmalted barley, rice, maize, starch, and sugar, and the ratio of the malt and raw products to one another, the concentration of the malt and raw products in the mash, the decomposition temperatures and the times at which the temperatures are maintained, and the addition of decomposition enzymes not originating from malt. Continuous brewing processes are also already known. Hence it is possible to vary within wide limits not only the ratio of fermentable to non-fermentable extract ingredients, that is of sugar to non-sugar in the worts, but also the degree of decomposition of the nitrogen compounds, the so-called albumen solution. By "extract" is meant that part of the wort which is obtained on determining a ° Plato, and is composed essentially of fermentable and non-fermentable carbohydrates and some protein.

Wort concentrations of up to approximately 40° Plato can be obtained directly in the brewery. Concentrated worts of up to approximately 72° Plato can, however, also be produced, for example by an evaporation process. For a good yield the quantity of sugar subjected to yeast fermentation must be brought into conformity with the supply of other nutrients necessary for yeast fermentation, particularly nitrogen and phosphorus, which must be present in an assimilable form. To this end, worts having an assimilable nitrogen content of 0.025-0.05 kg and an assimilable P_2O_5 content of 0.01-0.02 kg per kg of sugar to be fermented may be used. If necessary these nutrients can be introduced into the substrate by the addition of compounds, such as products of albumen hydrolysis, ammonia, and phosphoric acid or its salts, urea, trace elements, propagation substances and the like. Such additives are unobjectionable if pure materials are used and are largely assimilated. In many cases, however, it is preferable that all required nutrients are present in the starting material.

If a certain content of for example alcohol or other metabolism products of anaerobic fermentation is required in the fermented substrate, or if for example residues of dissolved oxygen are to be removed from the substrate, then the aerobic yeast fermentation may be followed by

anaerobic fermentation. When carrying out this latter step the same microorganisms and temperature and pH conditions can be applied as during the yeast fermentation; however, it is also possible to use other methods, for example to carry out a fermentation process of the type usually carried out in a brewery after the yeast fermentation step, after first separating the microorganisms and adding further unfermented worts and new pitching yeast. The step of supplying new pitching yeast may also include anaerobic fermentation phases. It is thus possible to adapt the process according to the invention to given conditions and regulate the required end product to a very high degree. The yeast fermentation is usually carried out in conventional yeast production fermenters. Since the addition of foam-suppressing agents is generally undesirable the foam formed during fermentation can be destroyed mechanically.

In order to develop a good flavour, the temperature during the aerobic fermentation may be maintained at from 5 to 35°C, more particularly from 10 to 20°C, preferably at approximately 12°C. The pH value of the worts may be maintained during the aerobic fermentation at from 4.0 to 6.0, preferably from 4.3 to 4.4.

Advantageously, the yeast introduced may be of a species of the genus "Saccharomyces."

After fermentation the yeast is separated, the yeast obtained as by-product being suitable for use as a nutrient, feed or baker's yeast for the production of yeast derivatives, thus making the method according to the invention particularly economical.

Both hopped and unhopped worts can be used for fermentation, the latter being preferred in view of the further processing of the yeast. When using unhopped worts the fermented wort can be cold-hopped.

To obtain low-alcoholic or non-alcoholic beverage the conditions during fermentation must be so selected that the oxygen supply is appropriate for the particular quantity of sugar to be fermented, so that no noticeable alcohol formation takes place. Therefore the aerobic fermentation is carried out as as feed process, the feed of the nutrient solution and/or air being regulated in a known manner in accordance with the alcohol content of the worts being fermented or that of the exhaust air. A feed process is one in which during fermentation a non-fermenting wort is to fed to the wort in fermentation.

It is possible to carry out the fermentation both in batches and continuously. For a batch process a nutrient solution having a concentration of up to approximately 72° Plato may be used; for a continuous process a concentration of up to approximately 40° Plato may be used. For a batch process a certain quantity of water or even of low-grade worts, for example sparging water, may be supplied in the fermenter together with the pitching yeast and any additional nutrients, whereupon, whilst aerating and circulating the contents of the fermenter, concentrated worts of up to 72° Plato together with further additional nutrients if required, may be fed in proportion as they are consumed by the yeast, until the desired concentration is reached. In the case of continuous yeast fermentation the process can again be begun with an initial supply of low concentration, but then continued without any notable further dilution by feeding concentrated worts of up to approximately 40° Plato, while continuously supplying additional nutrients if necessary. In order to accelerate the fermentation process the operation may be carried out with recycling of yeast. As soon as a steady state is reached the fermented substrate which is continuously drawn off has the desired concentration. In conventional alcoholic wort fermentation for making beer or fermented beverages, a wort of relatively low grade (usually 12° Plato) is introduced as substrate. A substantial increase in the concentration is not possible even by the continuous feed method, particularly since beer yeast stops fermenting on reaching an alcohol content of approximately from 5.5 to 6.0% by weight. In the method according to the invention end concentrations are obtainable in the fermented substrate corresponding to an initial concentration (original wort content) of approximately 40° Plato. This unexpectedly good result is apparently due to removal of the inhibiting action of the alcohol.

The yeast is usually separated from the fermented substrate in a known manner, for example by sedimentation, centrifuging or filtering. After removal of the yeast the fermented worts can then be subjected to further treatment, in particular it may be carbonated, given a head, or have alcohol added. The fermented worts may also be diluted before filling to the desired extract content. They may, however, also be used as a starting material for a further concentration process which may then be carried out very economically because less water has to be lost than is the case when using for example conventional beer as a starting material.

The method of producing fermented beverages according to the invention has the following particular advantages:

1. Normal as well as low-alcoholic beers, in particular alcohol-free fermented beverages may be produced with final fermenta-

tion, or, if desired, any intermediate degree of fermentation. The beverages produced have an optimum flavour and colloidal stability, and exhibit a very close approximation to the character of normally fermented beers.

2. Beer or fermented beverage concentrates may be produced in one operation during the actual fermentation up to an original wort content of approximately 40° Plato and over by introducing correspondingly concentrated worts. Thus the method is particularly economic even when compared to the production of normal beers.

3. Large quantities of yeast as a by-product are obtained, which can be used in various ways, for example as nutrient or feed yeast, baker's yeast, or yeast for obtaining derivatives, and which is free of bitter substances when unhopped worts are used. The beverage can be subsequently bittered according to requirements, for example by means of pre-isomerized hop extracts. The invention will be further described with reference to the following examples;

Example 1

1500 ml brewing water and pitching yeast corresponding to 15.4 g dry yeast substances were placed in a 5-litre small fermenter, which was provided with a mechanical foam-destroying device. The speed of the rotary aerator was set at 2000 r.p.m. and the supply of air at 0.1 Nm^3/h. 1 litre malt wort of 32.2° Plato and having a ratio of sugar to non-sugar of 1:0.92 together with 500 ml of a solution of 11 ml ammonia water and 4.7 g diammonium phosphate were fed uniformly into the fermenter over a period of 8 hours, the ratio of oxygen to sugar in the wort being 1.33 kg oxygen per kg of sugar. The fermentation temperature was maintained at 28 to 30°C and the pH at between 4.0 and 5.0 by regulation with 1N-NaOH and 1N-H_2SO_4. Aeration was then continued for a further half an hour. After termination of the fermentation process and separation of the yeast in a laboratory centrifuge, a fermented wort having 7.0% effective extract and 0.66 vol. —% alcohol was obtained. After addition of hop extract, filtration, and carbonation, a low-alcohol fermented beverage similar to beer was obtained ready for drinking. The quantity of yeast obtained corresponded to 73.0 g dry yeast substance.

Example 2

1450 mls brewing water and pitching yeast corresponding to 40 g dry yeast substance were placed in the same small fermenter as in Example 1, and the aerator speed set at 1500 r.p.m. and the quantity of the air supply at 0.055 Nm^3/h. A part of the stream of the exhaust air was passed over a device for continuously determining the alcohol content. 1550 ml of a wort of 61° Plato and having a sugar to non-sugar ratio of 1:2.95 was continuously fed in into the fermenter, the wort containing 7.5 g assimilable nitrogen and 3.2 g assimilable P_2O_5 per litre, and the ratio of oxygen to sugar in the wort being 2.2 kg oxygen per kg of sugar. The feed was regulated so that the alcohol content of the mash throughout the fermentation was approximately 0.2 vol. —%. The fermentation temperature was maintained at 12-15°C and the pH at 4.0 to 5.0. The feed was supplied for 40 hours. The aeration was then continued for a further 1 hour, the alcohol content of the mash dropping to 0.03 vol.—%. The yeast was then again centrifuged. The resulting fermented wort was practically free of sugar and had a content of 27.0% by weight effective extract and 0.03 vol.% alcohol. After bittering with hop extract, a beer concentrate was obtained which by dilution with 5 parts water, addition of alcohol, and carbonation, was converted into a beverage similar to a lager. The quantity of yeast separated by centrifuging amounted to 198 g dry yeast substance.

Example 3

Initially the same procedure as described in Example 2 was carried out. However, after half the quantity of wort, i.e. 775 ml, had been fed in and yeast-fermented in an alcohol-free manner after 21 hours, the speed of the aerator was reduced to approximately 100 r.p.m. and the air supply to the fermenter was stopped. The remaining 775 ml wort was then added without aeration over a period of 10 hours and thus fermented with formation of alcohol. After a further 3 hours the fermented wort and the yeast were separated by centrifuging. Analysis of the wort indicated 27.5% by weight effective extract and 2.8 vol. —% alcohol. This concentrate was somewhat superior in flavour to that obtained in Example 2. The quantity of yeast obtained amounted to 126 g dry yeast substance.

In this example the ratio of oxygen to sugar in the wort during the aerobic phase was 2.26 kg oxygen per kg of sugar; during the aerobic and anaerobic phases the ratio was 1.13 kg oxygen per kg of sugar.

WHAT WE CLAIM IS:—

1. A method of producing fermented beverages,, or concentrates which may be reconstituted by dilution to form fermented beverages, by fermentation of worts prepared at least partially from grain or malt mashes, comprising carrying out the fermentation under aerobic conditions in the presence of a continuous supply of oxygen or a free oxygen-containing gas into the whole wort to provide from 0.5 to 5.0

kg oxygen per kg of fermentable carbohydrates present in the wort, whereby substantially all fermentable carbohydrates are assimilated by yeast and no or only a little alcohol is formed, separating the yeast off after fermentation, and subjecting the fermented liquid to at least one of the steps of sedimentation, centrifugation, filtration, cold-hopping, adding alcohol, providing a head, carbonation and dilution.

2. A method as claimed in Claim 1 wherein the free oxygen-containing gas is air.

3. A method as claimed in Claim 1 or 2 wherein the weight ratio of fermentable to non-fermentable extract ingredients in the worts is from 1:0.1 to 1:10.

4. A method as claimed in Claim 3 wherein the said ratio of fermentable to non-fermentable exaract ingredients is from 1:0.3 to 1:3.

5. A method as claimed in any of Claims 1 to 4 wherein the worts have an assimilable nitrogen content of from 0.025 to 0.05 kg and an assimilable P_2O_5 content of from 0.01 to 0.02 kg per kg of fermentable carbohydrates.

6. A method as claimed in any of Claims 1 to 5 comprising mechanically destroying the foam formed during fermentation.

7. A method as claimed in any of Claims 1 to 6 comprising maintaining the temperature during the aerobic fermentation at from 5 to 35°C.

8. A method as claimed in Claim 7 comprising maintaining the said temperature at from 10 to 20°C.

9. A method as claimed in Claim 8 comprising maintaining the said temperature at 12°C.

10. A method as claimed in any of Claims 1 to 9 comprising maintaining the pH value of the worts during the aerobic fermentation at from 4.0 to 6.0.

11. A method as claimed in Claim 10 comprising maintaining the said pH value at from 4.3 to 4.4.

12. A method as claimed in any of Claims 1 to 11 wherein the yeast introduced is a species of the genus "Saccharomyces."

13. A method as claimed in any of Claims 1 to 12 wherein the aerobic fermentation is carried out as a feed process, comprising regulating the feed of at least one of the nutrient solution and air in accordance with the alcohol content of the worts being fermented or that of the exhaust air.

14. A method as claimed in Claim 13 comprising carrying out the fermentation as a batch process wherein nutrient solution is supplied at a concentration of up to 72° Plato.

15. A method as claimed in Claim 13 comprising carrying out the fermentation as a continuous process wherein nutrient solution is supplied at a concentration of up to 40°Plato.

16. A method according to claim 1 of producing fermented beverages, or concentrates which may be reconstituted by dilution to form such beverages, substantially as herein described with reference to any of the foregoing examples.

17. A fermented beverage, or concentrate which may be reconstituted by dilution to form such a beverage, when produced by the method as claimed in Claims 1 to 16.

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Agents for the Applicant.

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